8.1 Air Quality

GWF Energy LLC proposes to build and operate the Tracy Peaker Project (TPP), a nominal 169-megawatt (MW) simple-cycle power plant, on a nine-acre, fenced site within a 40-acre parcel in an unincorporated portion of San Joaquin County. The site is located immediately southwest of Tracy, California, and approximately 20 miles southwest of Stockton, California. The TPP would consist of the power plant, an onsite 230-kilovolt (kV) switchyard, an approximately five-mile, 230-kV electric transmission line, an approximately 1,470-foot water supply pipeline (as measured from the fence line), an onsite natural gas supply interconnection, and improvements to an existing dirt access road approximately one mile in length. An approximately 5.2-acre area west of the plant fence line and within the 40-acre parcel would be used for construction laydown and parking. Figure 2-1 shows the regional location of the TPP site. Figure 2-2 shows the immediate site location of the TPP, including the location of the proposed generating facility and the proposed transmission, water supply, and access routes.

This analysis of the potential air quality impacts of the TTP was conducted according to California Energy Commission (CEC) power plant siting requirements. The analysis also addresses the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD) requirements for Authority to Construct and Permit to Operate. The details of the analysis are contained in the following sections:

- Section 8.1.1 describes all applicable laws, ordinances, regulations, and standards (LORS).
- Section 8.1.2 describes the local environment surrounding the TPP site. Meteorological data including wind speed and direction (i.e., wind roses), temperature, and precipitation are discussed, and ambient concentrations for the appropriate criteria pollutants are summarized.
- Section 8.1.3 provides an analysis of best available control technology (BACT) for gas-fired turbines, and explains how the use of dry, low nitrogen oxide (NO_x) combustors and selective catalytic reduction (SCR) with ammonia injection meet NO_x BACT requirements, and how use of an oxidation catalyst will meet BACT requirements for carbon monoxide (CO). BACT controls for the diesel generator are also proposed. Also, mitigation of fugitive dust during construction is discussed.

- Section 8.1.4 evaluates the TPP's air quality impacts from NO_x, CO, sulfur dioxide (SO_2), volatile organic compounds (VOCs), and particulate matter less than 10 micrometers in diameter (PM_{10}) emissions. Emission estimates are presented for these pollutants for project construction and operation over a range of operating modes, including startup and shutdown. The modeling analysis conducted for nitrogen dioxide (NO_2), CO, SO_2, and PM_{10} is presented. The results indicate that the TPP will not cause an exceedance of the California and federal ambient air quality standards.
- Section 8.1.5 describes the TPP emissions and planned use of emission reduction credits.
- Section 8.1.6 describes TPP compliance with all applicable LORS. Also, Table 8.1-29 summarizes TPP compliance with each LORS.
- Section 8.1.7 lists the agency contacts for the air quality assessment.
- Section 8.1.8 lists the references for the air quality assessment.

Some relevant information is presented in other sections of this Application for Certification (AFC), including an evaluation of toxic air pollutants (see Section 8.6, Public Health) and information related to the fuel characteristics (see Section 7.0, Natural Gas Supply), heat rate, and expected capacity factor of the proposed facility (see Section 2.0, Project Description).

8.1.1 Laws, Ordinances, Regulations, and Standards

The LORS that apply to the potential air quality impacts from the TPP are described below. These LORS are administered (either independently or cooperatively) by the U.S. Environmental Protection Agency (U.S. EPA) Region IX, the CEC, the California Air Resources Board (CARB), and the SJVUAPCD.

8.1.1.1 Ambient Air Quality Standards

U.S. EPA, in response to the federal Clean Air Act of 1970, established National Ambient Air Quality Standards (NAAQS) in 40 Code of Federal Regulations (CFR) Part 50. The NAAQS include both primary and secondary standards for six "criteria" pollutants. These criteria pollutants are ozone, CO, NO_2, SO_2, PM_{10}, and lead. Primary standards were established to protect human health, and secondary standards were designed to protect property and natural ecosystems from the effects of air pollution.

The 1990 Clean Air Act Amendments established attainment deadlines for all designated areas that did not attain the NAAQS. In addition to the federal standards described above, a new federal standard for particulate matter less than 2.5 μm in diameter ($PM_{2.5}$) and a revised ozone standard were promulgated in July 1997. Under an interim policy, the PM_{10} and 1-hour ozone standards will continue to be implemented for the next several years while the new standards are being phased in. The State of California has adopted state standards (SAAQS) that are in some cases more stringent than the NAAQS. The state and federal standards relevant to the TPP are summarized in Table 8.1-1.

The U.S. EPA, CARB, and the local air pollution control districts determine air quality attainment status by comparing local ambient air quality measurements from the state or local ambient air monitoring stations with the NAAQS and SAAQS. Those areas that meet ambient air quality standards are classified as "attainment" areas; areas that do not meet the standards are classified as "nonattainment" areas. Areas that have insufficient air quality data may be identified as unclassifiable areas. These attainment designations are determined on a pollutant-by-pollutant basis. San Joaquin County has been designated as a federal and state nonattainment area for ozone and PM_{10}. The federal attainment status for all other criteria pollutants is considered unclassified due to insufficient monitoring data; however, California considers the area to be in attainment for these pollutants. Table 8.1-2 presents the attainment status (both federal and state) for San Joaquin County, which is located in SJVUAPCD jurisdiction.

As mentioned above, both U.S. EPA and CARB are involved with air quality management in San Joaquin County, along with SJVUAPCD. The area of responsibility for each of these agencies is described below.

U.S. EPA has ultimate responsibility for ensuring, pursuant to the Clean Air Act Amendments that all areas of the U. S. meet, or are making progress toward meeting, the NAAQS. The state of California falls under the jurisdiction of U.S. EPA Region IX, which is headquartered in San Francisco. The U.S. EPA requires that all states submit State Implementation Plans for nonattainment areas that describe how the NAAQS will be achieved and maintained. The U.S. EPA has delegated this attainment responsibility to CARB.

CARB, in turn, has delegated attainment responsibility to regional or local air quality management districts (or air districts), such as SJVUAPCD. CARB is responsible for attainment of the California standards, implementation of nearly all phases of California's motor vehicle emissions program, and oversight of the operations and programs of the regional air districts.

Each air district is responsible for establishing and implementing rules and control measures to achieve air quality attainment within its district boundaries. The air district also prepares an air quality management plan that includes an inventory of all emission sources within the district (both man-made and natural), a projection of future emissions growth, an evaluation of current air quality trends, and an assessment of any rules or control measures needed to attain the air quality standards. This air quality management plan is submitted to CARB, which then compiles the plans from all air districts within the state into the State Implementation Plan. The responsibility of the air districts is to maintain an effective permitting system for existing, new, and modified stationary sources, to monitor local air quality trends, and to adopt and enforce such rules and regulations as may be necessary to achieve the air quality standards.

8.1.1.2 Prevention of Significant Deterioration Requirements

In addition to the ambient air quality standards described above, the federal Prevention of Significant Deterioration (PSD) program has been established to protect deterioration of air quality in those areas that already meet NAAQS. Specifically, the PSD program specifies allowable concentration increases for attainment pollutants due to new emission sources. These increases allow economic growth while preserving the existing air quality, protecting public health and welfare, and protecting Class I areas (national parks and wilderness areas). The PSD regulations require major stationary sources to undergo a preconstruction review that includes an analysis and implementation of BACT, a PSD increment consumption analysis, an ambient air quality impact analysis, and analysis of air-quality-related values. Although U.S. EPA Region IX has delegated enforcement of the PSD program in California, U.S. EPA Region IX currently retains PSD permitting authority in the SJVUAPCD.

An emission source is considered "major" when its potential to emit any regulated air pollutant exceeds 100 tons per year (tpy) (if it is one of 28 specified source categories). The TPP is not among these categories. Therefore, the PSD major-source threshold that applies to the proposed project is 250 tpy of any regulated air pollutant. The TPP will not be subject to PSD requirements, because estimated potential annual emissions are below the 250 tpy threshold for all regulated air pollutants.

8.1.1.3 Acid Rain Program Requirements

Title IV of the Clean Air Act Amendments applies to sources of air pollutants that contribute to acid rain formation, including certain sources of SO_2 and NO_x emissions. Title IV is implemented by the U.S. EPA under 40 CFR 72, 73, and 75. Allowances of SO_2 emissions are set aside in 40 CFR 73. Sources subject to Title IV are required to obtain SO_2 allowances, to monitor their emissions, and obtain SO_2 allowances when a new source is permitted. Sources such as the TPP that use pipeline-quality natural gas are exempt from many of the acid rain program requirements. However, these sources must still estimate SO_2 and carbon dioxide (CO_2) emissions, and monitor NO_x emissions with certified continuous emissions monitoring systems. All subject facilities must submit an acid rain permit application to U.S. EPA within 24 months of commencement of operation.

8.1.1.4 New Source Performance Standards

New Source Performance Standards (NSPS) have been established by U.S. EPA to limit air pollutant emissions from certain types of new and modified stationary sources. The NSPS regulations are contained in 40 CFR 60 and cover nearly 70 source categories. Stationary gas turbines are regulated under subpart GG. The enforcement of NSPS has been delegated to the SJVUAPCD, and the NSPS regulations are incorporated by reference into the District's Rule 4001.

In general, local emission limitation rules or BACT requirements are more restrictive than the NSPS requirements. For example, the NO_x emissions from the TPP's stationary gas turbine will be controlled to less than 5 parts per million by volume dry (ppmvd) at 15 percent oxygen, significantly less than the NSPS limit of 92 ppmvd at 15 percent oxygen.

The NSPS NO_x standard was calculated according to 40 CFR 60.332 as follows:

$$STD = 0.0075 \text{ x } \left(\frac{14.4}{Y}\right) + F$$

Where: STD = Allowable NO_x emission standard (% by volume at 15 percent oxygen dry basis)

Y = Manufacturer's rated heat rate based on lower heating value (kJ/W-hr)

F = NO_x emission allowance for fuel-bound nitrogen

The allowable NO_x emission standard was calculated as 0.0092 percent by volume (or 92 ppmvd) for the TPP based on the following:

Y = 11,180 Btu/kW-hr (or 11.80 kJ/W-hr)

F = 0 (worst-case condition)

The NSPS fuel requirements for SO_2 will be satisfied by the use of natural gas, and emissions and fuel monitoring will be performed to comply with NSPS, acid rain, and other regulatory requirements.

8.1.1.5 Federally Mandated Operating Permits

Title V of the Clean Air Act requires U.S. EPA to develop a federal operating permit program that is implemented under 40 CFR 70. This program is administered in San Joaquin County by SJVUAPCD under Rule 2520. Each major source must obtain a Part 70 permit. Permits must contain emission estimates based on potential-to-emit, identification of all emissions sources and controls, a compliance plan, and a statement indicating each source's compliance status. The permits must also incorporate all applicable federal requirements. The

TPP would be a major source subject to Title V. Permit applications must be submitted within 12 months after plant startup.

8.1.1.6 Power Plant Siting Requirements

Under the California Environmental Quality Act (CEQA), the CEC has been charged with assessing the environmental impacts of each new power plant and considering the implementation of feasible mitigation measures to prevent any significant impacts. CEQA Guidelines (Title 14, California Code of Regulations, Section 15002[a][3]) state that the basic purpose of CEQA is to "prevent significant, avoidable damage to the environment by requiring changes in projects through the use of alternatives or mitigation measures when the governmental agency finds the changes to be feasible."

The CEC's siting regulations state that, unless certain conditions justifying an override are present, a new power plant can only be approved if the proposed project complies with all federal, state, and local air quality LORS that govern the construction and operation of the project. A project must demonstrate that emissions will be appropriately controlled to mitigate siginificant project impacts, and that it will not jeopardize attainment or maintenance of ambient air quality standards. Cumulative impacts, impacts due to pollutant interaction, and impacts from noncriteria pollutants must also be considered.

8.1.1.7 Air Toxics "Hot Spots" Program

As required by the California Health and Safety Code Section 44300, all facilities with criteria air pollutant emissions in excess of 10 tons per year are required to submit air toxic "Hot Spots" emissions information. This requirement is applicable only after the start of operation. Section 8.6 (Public Health) of this AFC indicates that there will not be significant air toxics impacts from the TPP.

8.1.1.8 Determination of Compliance, Authority to Construct, and Permit to Operate

Under Rule 2010, SJVUAPCD regulates the construction, alteration, replacement, and operation of sources that may emit air contaminants through the issuance of air permits such as the Authority to Construct (ATC) and Permit to Operate (PTO). This permitting process allows the SJVUAPCD to adequately review new and modified air pollution sources to ensure compliance with all applicable prohibitory rules and to ensure that appropriate emission controls are used. An ATC allows for the construction of the air pollution source and remains in effect until the PTO application is granted, denied, or canceled. For power plants licensed under the siting jurisdiction of the CEC, the SJVUAPCD issues a Determination of Compliance in lieu of an ATC. The DOC is incorporated into the CEC license. Once the project commences operation and demonstrates compliance with the DOC, the SJVUAPCD will issue a PTO. The PTO specifies conditions that the project must meet in order to comply with other air quality standards, and will incorporate applicable DOC requirements.

8.1.1.9 New Source Review Requirements

New Source Review (NSR) rules establish the criteria for siting new and modified emission sources. SJVUAPCD has been delegated authority for NSR rule development and enforcement; the District's NSR rules are contained in Rule 2201. There are three basic requirements within the NSR rules. First, BACT must be applied to any new source that has pollutant emissions above specified threshold quantities. Second, all potential emission increases from the source above specified thresholds must be offset by real, quantifiable, surplus, permanent, and enforceable emission decreases in the form of emission reduction credits (ERCs). Third, ambient air quality impact assessments must be conducted to confirm that the proposed project does not cause or contribute to a violation of a NAAQS or SAAQS or jeopardize public health.

8.1.1.10 Other Prohibitory Rules

Three applicable SJVUAPCD rules address operation emission limits for the TPP: Rule 4201, Rule 4703, and Rule 4801. Rule 4201 limits total suspended particulate matter emissions from any source operation to 0.1 grains per cubic foot of gas at dry standard conditions. Rule 4703 limits NO_x and CO emissions from stationary gas turbines rated at equal to or greater than 0.3 MW. To demonstrate compliance with Rule 4703, an emission control plan must be submitted and emissions monitoring and recordkeeping must be performed. Rule 4801 limits the discharge of sulfur compounds from any source operation to 0.2% by volume calculated as SO_2 on a dry basis.

Two SJVUAPCD rules apply to the TPP that prohibit visible emissions and emissions that may be considered a nuisance. Rule 4101 (Visible Emissions) limits emissions of visible air contaminants by prohibiting any emissions that exceed darkness and opacity levels designated as No. 1 on the Ringelmann Chart. Rule 4102 (Nuisance) prohibits any emissions "which cause injury, detriment, nuisance, or annoyance to any considerable number of persons or to the public or which endanger the comfort, repose, health or safety of any such person or the public or which cause or have a natural tendency to cause injury or damage to business or property."

Applicable fugitive dust requirements are implemented by SJVUAPCD Rules 8010 and 8020. Rule 8010 identifies specific activities subject to dust control (e.g., land leveling, grading, cut-and-fill grading, and the erection or demolition of any structure, etc.). This rule also defines "reasonably available control measures" for dust control (e.g., application of water, chemical stabilizers or other liquids, covering, paving, compacting, planting, etc.) and stipulates that stabilizers should not violate State Water Quality Control Board standards. Rule 8020 applies specifically to construction and requires that dust control be implemented for the duration of construction. Also, this rule states that visible dust emissions can not exceed an opacity limit of 40 percent for a period or periods aggregating to more than three minutes in any one hour.

8.1.2 Affected Environment

This section describes the regional climate and meteorological conditions that influence the transport and dispersion of air pollutants as well as existing air quality within the region of the TPP. The data presented in this section are representative of the climatological and meteorological conditions at the TPP site.

The site is approximately 175 feet above sea level in the northwestern corner of the San Joaquin Valley. The nearest Class I areas are Pt. Reyes National Seashore to the northwest, Yosemite National Park to the east, and Pinnacles National Monument to the south. However, none of these Class I areas is within a 100-kilometer radius of the site.

8.1.2.1 Climatology

The climate of the region, along with much of the West Coast of the country, is controlled by a semipermanent high-pressure system that is centered over the northeastern Pacific Ocean. In the summer, this strong high-pressure system results in clear skies inland and coastal fog, and the project site typically experiences temperatures similar to those of inland areas. Very little precipitation occurs during the summer months because storms are blocked by the high-pressure system. Beginning in the fall and continuing through the winter, the high pressure weakens and moves south, allowing storm systems to move through the area. Temperature, winds, and rainfall are more variable during these months. The project site receives an average of 14.5 inches of rain annually.

Long-term average temperature and precipitation data have been collected at the Tracy Carbona Station, the nearest surface meteorological station to the project site; these data are presented in Table 8.1-3. The data indicate that July is usually the warmest month of the year, with a normal daily maximum temperature of 93.8 °F, and a normal daily minimum of 56.8 °F. In the fall and spring, the afternoon temperatures are mild, in the 60s and 70s, while nights are cooler, in the 40s and 50s. In the winter, temperatures are cool in the afternoon and crisp at night. The coldest month is usually January, with a normal daily maximum of 54.1 °F and a normal daily minimum of 36.7 °F.

Figures 8.1-1 through 8.1-4 present the predominant wind patterns in the project area. As seen on Figure 8.1-1, the predominant surface winds in the project area are from the west-southwest and the west. The wind speeds are higher during the spring and summer months. Quarterly wind frequency distribution tables are located in Appendix B. Appendix B also contains wind roses and wind frequency distribution tables showing annual conditions as well as winds by stability class.

Atmospheric stability and mixing heights are important parameters in the determination of pollutant dispersion. Atmospheric stability reflects the amount of atmospheric turbulence and mixing. In general, the less stable an atmosphere, the greater the turbulence, which results in more mixing and better dispersion. The mixing height, measured from the ground upward, is the height of the atmospheric layer in which convection and mechanical turbulence promote mixing. Good ventilation results from a high mixing height and at least moderate wind speeds within the mixing layer.

Airflow in the San Joaquin Valley can be characterized by up-valley and down-valley winds. The down-valley winds are generally caused by airflows into the valley from the Carquinez Strait and the Altamont Pass that then flow south. The horizontal transport of air in the project area is affected by strong diurnal wind regimes, which results in a pronounced west/west-southwest component to the wind rose.

8.1.2.2 Existing Air Quality

Ambient air quality standards have been set by both the federal government and the State of California to protect public health and welfare with an adequate margin of safety. Pollutants for which NAAQS or SAAQS have been set are often referred to as "criteria" air pollutants. The term is derived from the comprehensive health effects review that culminates in pollutant-specific air quality criteria, which precede NAAQS and SAAQS standard setting. These standards are reviewed at a legally prescribed frequency and revised as new health effects data warrant.

Each NAAQS or SAAQS is based on a specific averaging time over which the concentration is measured. Different averaging times are based upon protection of short-term, high dosage effects or longer-term, low dosage effects. NAAQS may be exceeded no more than once per year. SAAQS are not to be exceeded.

The project site is in San Joaquin County, very close to the border between the San Francisco Bay Area and San Joaquin Valley Air Basins. The monitoring station closest to the proposed project site is the Tracy Patterson Pass Road Station. There are also several monitoring stations in Stockton, less than 20 miles to the northeast. However, these stations do not measure all criteria pollutant concentrations, and data from other stations are necessary. Monitoring stations at Bethel Island Road and Concord (Contra Costa County) and at North Highlands (Sacramento County) are also located near the project site. Gaseous pollutants monitored at these stations include ozone, CO, NO_x, SO_2 and PM_{10}. Air quality measurements taken at these stations are presented in Tables 8.1-4 through 8.1-8. For air quality impact analysis, the maximum background concentration from the past three years from all monitoring stations was used.

The monitoring data indicate that air quality complies with NAAQS and SAAQS for NO_2 at the Tracy and Stockton monitoring stations. The air quality complies with the standards for SO_2 for all averaging periods at North Highlands, Concord, and Bethel Island Road monitoring stations. No SO_2 data were available at monitoring stations closer to the site.

Table 8.1-4 shows that the federal one-hour ozone standard of 0.12 ppm has been exceeded in the last five years at the Tracy station. The more stringent state ozone standard of 0.09 ppm was exceeded each year for the past five years at every station (and as many as 24 times in 1996). The federal 8-hour ozone average standard of 0.08 ppm has also been exceeded every year. However, the federal standard requires maintaining 0.08 ppm as a three-year average of the fourth-highest daily maximum value. Therefore, the number of days that the maximum concentration exceeds the standard concentration is not the number of violations of the standard for the year.

The PM_{10} data in Table 8.1-5 show that the 24-hour average SAAQS of 50 micrograms per cubic meter ($\mu g/m^3$) has been exceeded every year at San Joaquin County monitoring stations. The annual geometric mean (also called the state annual average) is a geometric mean of all measurements. The annual arithmetic mean (also called the national annual average) is an arithmetic average of the four arithmetic quarterly averages. Most of the annual geometric and arithmetic mean concentrations frequently exceeded the California PM_{10}

ambient air quality standard in Stockton. However, these values are still below the federal PM_{10} standard of 50 $\mu g/m^3$.

The data in Table 8.1-6 show that maximum 8-hour average CO levels comply with the NAAQS and SAAQS of 9.0 ppm.

8.1.3 Best Available Control Technology

Pursuant to SJVUAPCD Rule 2201, BACT is required for NO_x, VOC, PM_{10}, and SO_2 emissions from any new or modified emission unit that exceed 2 pounds per day, and CO emissions that exceed 550 pounds per day. The SJVUAPCD defines BACT as the most stringent emission limit or control technology that either:

1. Has been achieved in practice; or
2. Is contained in a State Implementation Plan approved by U.S. EPA, unless demonstrated not to be achievable; or
3. Emission limits found by the Air Pollution Control Officer to be feasible and cost-effective for such class or category of sources or specific source.

To identify feasible emission limits, several information sources were consulted, including the following:

- U.S. EPA's BACT/Lowest Achievable Emission Rate (LAER) Clearinghouse and updates
- CARB's BACT Clearinghouse database and CARB's BACT Guidelines for Power Plants (adopted 7/22/99)
- SJVUAPCD BACT Guideline 3.4.2
- South Coast Air Quality Management District BACT Guidelines Manual
- Discussions with permitting staff from U.S. EPA Region IX and the SJVUAPCD
- Recent CEC Applications for Certification

8.1.3.1 BACT Assessment for the Gas Turbines

The 1977 Clean Air Act established revised conditions for the approval of preconstruction permit applications under the PSD program. One of these requirements is that the BACT be installed for all pollutants emitted in significant amounts from new major sources or modifications, as regulated under the Clean Air Act. The new major sources proposed for this project include two combustion turbine generators (CTGs) that are subject to the BACT/LAER rules. This document presents the BACT/LAER analysis and results for the new major sources on this project.

General Description. This section describes the basis of this BACT/LAER analysis. The TPP will consist of two GE PG7121 (EA) simple-cycle CTGs. Each combustion turbine unit will consist of one turbine and one generator, operating in a simple-cycle mode. The net output per CTG unit will be nominally 84.4 MW while firing natural gas. In addition, the CTG units are well-suited for large load changes or quick and frequent startups and shutdowns.

The proposed operating scenario for the combustion turbines is operation up to 8,000 hours per year for each unit. For the purpose of this BACT analysis, emissions were evaluated at an average ambient temperature of 59 °F and 60 percent relative humidity during natural gas operation at 8,000 hours per year at full load. Table 8.1-9 shows the emission rates for each combustion turbine firing natural gas at 100 percent of base load and the average annual site temperature of 59 °F.

To bring consistency to the BACT process, the U.S. EPA authorized the development of a guidance document (March 15, 1990) on the use of the “top-down” approach to BACT determinations. The first step in a top-down BACT analysis is to determine, for the pollutant in question, the most stringent control technology and emission limit available for a similar source or source category. Technologies required under LAER determinations must be considered. These technologies represent the top control alternative under the BACT analysis. If it can be shown that this level of control is infeasible on the basis of technical, economic, energy, and environmental impacts for the source in question, then the next most stringent level of control is identified and similarly evaluated. This process continues until the BACT level under consideration cannot be eliminated by any technical, economic, energy, or environmental consideration.

Economic analysis used to determine the capital and annualized costs of the control technologies were based on methodologies provided in the U.S. EPA's *Best Available Control Technology Draft Guidance* (October 1990), *"Top Down" Best Available Control Technology Guidance* (March 1990), *The Office of Air Quality Planning and Standards (OAQPS) Control Cost Manual* (February 1996, Fifth Edition), internal project developer cost factors, and vendor budgetary cost quotes. Table 8.1-10 lists the economic criteria used in the analysis of BACT alternatives.

NO_x LAER Analysis. The objective of this analysis is to indicate LAER for NO_x emissions from the combustion turbines. Unless otherwise noted, the NO_x emission rates described in this section are corrected to 15 percent oxygen.

A review of the U.S. EPA and CARB BACT/LAER Clearinghouse documents indicates that the most stringent NO_x emission limit for a natural-gas-fired, simple-cycle CTG unit is 5 ppm. This limit has been set for one project in California, the Carson Energy Project in metropolitan Sacramento (42 MW). Both facilities use water injection and high-temperature SCR to control NO_x emissions. A second facility in Kern County, the SoCalGas, Wheeler Ridge Gas Compression station has a permit limit in excess of 5 ppmvd. The principal difference in the two applications is the exhaust temperature. The Carson Energy Facility is an aero-derivative CTG that operates with an exhaust temperature of 850 °F. The Wheeler Ridge facility is a frame CTG and operates at an exhaust temperature of approximately 1,000 °F. The Carson Energy facility consists of a 450 MMBtu/hr CTG GE LM6000 gas turbine generator set that is capable of producing 42 MW. According to the CARB Clearinghouse database, the unit can be fired on natural gas or co-fired with digester gas and natural gas. However, the Sacramento Metropolitan Air Quality Management District has indicated that the facility has never fired digester gas. The SoCalGas Wheeler Ridge facility has a Solar Model H 47.64 MMBtu/hr gas turbine that fires natural gas in order to drive two Solar Model two-stage centrifugal gas compressors.

Furthermore, CEC staff recently recommended the approval of a simple-cycle project listed in the South Coast Air Quality Management District database with NO_x levels of 5 ppmvd at 15 percent oxygen. The facility will be located in Chino, California and consist of four GE LM6000 Enhanced Sprint turbines rated at 45 MW each. The NO_x emissions are to be controlled by water injection and SCR. Since the proposed turbines operate in simple-cycle mode, a tempering air system will be installed to ensure that the flue gas temperature does not exceed 885 °F, the upper operating range of the SCR catalyst.

Two other potential technologies for the control of NOx emissions are XONON™ and SCONOx™. The XONON™ combustion system improves the combustion process by lowering the peak combustion temperature to prevent the formation of NO_x while avoiding the increases in CO and unburned hydrocarbons associated with other NO_x control technologies (such as water injection and DLN). Most gas turbine emission control technologies remove air contaminants from exhaust gas prior to release to the atmosphere. In contrast, the XONON™ system partially combusts the fuel in the catalyst module, then completes the combustion downstream of the catalyst. In the catalyst module, a portion of the fuel is combusted without a flame (i.e., at relatively low temperature) to produce a hot gas. A homogeneous combustion region is located immediately downstream, where the remainder of the fuel is combusted.

XONON™ represents an available control technology for a 170-MW F-Class turbine, although the first demonstration unit on an F-Class turbine will be the Pastoria project in Kern County. A joint venture agreement is in place between Catalytica and General Electric (GE) to eventually develop XONON™ as Original Equipment Manufacturer and retrofit equipment for the entire GE turbine line. It is critical to note that GE does not currently offer a XONON™ combustion option for the GE 7EA turbine line, which is proposed for the TPP. Therefore, XONON™ is not a currently available control technology for the TPP.

SCONOx™ is a new innovative post-combustion control system produced by Goal Line Environmental Technologies that began commercial operation at the Federal Plant in Vernon, California in December 1996. The Federal Plant is owned by Sunlaw Cogeneration Partners and consists of an LM2500 combustion turbine (approximately 28 MW) with a heat recovery steam generator. The SCONOx™ system uses a coated oxidation catalyst installed in the flue gas to remove both NO_x and CO without a reagent such as ammonia. CO is oxidized to CO_2 and exits the stack. The NO emissions are oxidized to NO_2 and then absorbed onto the catalyst. A dilute hydrogen gas is then passed through the catalyst periodically. This gas de-absorbs the NO_2 from the catalyst and reduces it to nitrogen prior to exit from the stack.

SCONOx™ operates in a temperature range between 300 ^oF and 700 ^oF. The TPP simple-cycle turbines, operating at exhaust temperatures of approximately 1,000 ^oF, will require a significant amount of temperation air to reduce the exhaust temperature to conform with the SCONOx™ temperature requirements. This introduces a significant technology risk for a system that to date has not been applied to a simple-cycle turbine. Therefore, SCONOx™ is not a currently available control technology for the TPP.

The current LAER limit for a simple-cycle CTG is 5 ppmvd at 15 percent oxygen, and this is the limit proposed for the TPP. NO_x emissions will be controlled by dry, low NO_x (DLN) combustor and SCR. The exhaust gas exiting the CTG will be tempered with ambient air to cool and control the exhaust gas to about 850 °F before the exhaust gas passes through the SCR.

CO BACT. The objective of this analysis is to determine BACT for CO emissions from the combustion turbines.

A review of the U.S. EPA and CARB BACT/LAER Clearinghouse documents and further contacts with the Sacramento Metropolitan Air Quality Management District indicate that the most stringent CO emissions limit for natural-gas-fired CTG unit is approximately 6 ppmvd at 15 percent oxygen for the Carson Energy Facility in California. The facility consists of a 450 MMBtu/hr GE LM6000 gas turbine generator set producing 42 MW. The unit can be fired on natural gas or co-fired with digester gas and natural gas. However, the facility currently fires only natural gas. An oxidation catalyst is used to control the emission levels of CO. It should be noted that the Carson Energy project represents LAER, which is located in nonattainment areas for CO and ozone (VOC control required). The TPP will achieve an emission rate of 6 ppmvd at 15 percent oxygen through use of an oxidation catalyst.

PM/PM_{10} LAER Analysis. The emission of particulate matter from the project will be controlled by ensuring that the combustion of fuel is as complete as possible and by minimizing SO_2 to SO_3 oxidation. The NSPS for combustion turbines does not establish a particulate emission limit. Natural gas contains only trace quantities of noncombustible material.

The manufacturer's standard operating procedures include filtering the turbine inlet air and combustion controls. The BACT/LAER Clearinghouse documents do not list any post-combustion particulate matter control technologies being used on combustion turbines. Consistent with the recent determinations referenced by the CARB Clearinghouse database, such as the La Paloma Generating Company, LLC, the use of low-sulfur fuel (natural gas with a total sulfur limit of 0.75 grains per standard cubic foot [gr/100 scf]) and combustion controls is considered LAER for particulate matter (PM), and this limit is proposed for the TPP. Particulate emissions (front catch only) will be limited to 5 lb/hr (0.0057 lb/MMBtu) and 10 lb/hr (0.0112 lb/MMBtu) for front- and back-half PM/PM_{10}, while firing natural gas at full load for each GE PG7121 (EA) CTG, based on data from operating GE units with dry, low NO_x combustors.

VOC LAER Analysis. The objective of this analysis is to indicate LAER for VOC emissions from the combustion turbines. Unless otherwise noted, the VOC emission rates described in this section are corrected to 15 percent oxygen.

A review of the U.S. EPA BACT/LAER and CARB BACT Clearinghouses indicates that the most stringent VOC emissions limit for a gas-fired combustion turbine is achieved through the application of an oxidation catalyst. Most oxidation catalyst applications listed assumed destruction rates of 10 percent. Only two projects show an emission reduction rate of any significance: the Combined Energy Resources project in the SJVUAPCD and the Crockett Cogeneration (C&H Sugar) project in the Bay Area Air Quality Management District. The 44 and 50 percent removals reportedly achieved on these projects may be discounted, however, due to the high-uncontrolled emissions rate for the projects.

The facility proposed for this project is located in a nonattainment area for ozone that regulates VOCs as a nonattainment pollutant since VOCs are a precursor to ozone. The current LAER limit for a CTG is 2 ppmvd at 15 percent oxygen (CARB, 1999) and is proposed for the TPP. The VOC emissions are to be controlled by DLN on the CTG and an oxidation catalyst.

Summary. The following is a summary of BACT/LAER determinations and associated emission rates for two GE PG7121 (EA) CTGs operating in simple-cycle mode to be installed at the TPP. Emissions are currently based on the GE PG7121 (EA) CTG unit firing only natural gas. In addition, the emissions for the CTGs are for full-load operation at 8,000 hours per year at an ambient average temperature of 59 °F.

- NO_x emissions:
  - LAER is the use of DLN and an SCR system with air dilution during natural-gas firing to achieve an emission limit of 0.0182 lb/MMBtu (18.06 lb/hr, 5 ppmvd at 15 percent oxygen).
- CO emissions:
  - BACT is the use of good combustion controls and CO catalyst to achieve a CO emission limit of 0.0129 lb/MMBtu (12.8 lb/hr, 6 ppmvd at 15 percent oxygen) during natural-gas firing.
- PM/PM_{10} emissions:
  - LAER is the use of good combustion controls with natural-gas firing and combustion air filters to achieve a PM/PM_{10} (front catch) limit of 0.0057 lb/MMBtu (5 lb/h) and 0.0112 lb/MMBtu (10 lb/hr) for front- and back-half PM/PM_{10}.
- VOC emissions:
  - LAER is the use of good combustion controls to achieve a VOC emission limit of 0.003 lb/MMBtu (3 lb/h, 2 ppmvd at 15 percent oxygen) during natural-gas firing.

8.1.3.2 BACT Assessment for Emergency Diesel Generator

The generator will only be operated periodically for required testing, except in an emergency situation. Add-on controls have not been used in practice on this type of source, due to the limited operation of the generator. Operation with low-sulfur fuel oil and restricted hours of operation meet BACT for all regulated pollutants.

NO_x Emission Control. The objective of the analysis is to determine BACT for NO_x emissions from the emergency diesel generator.

BACT/LAER Clearinghouse Reviews. A review of the U.S. EPA BACT/LAER and CARB BACT Clearinghouses indicates that the most stringent NO_x emission limit for a diesel-fired emergency internal combustion engine (2,340 hp, Detroit Diesel Model No. 16V-149TIB) is 2.04 lb/h (1.5 g/bhp-h) for the L.A. Times located in the South Coast Air Quality Management District in California. The unit controls NO_x emissions using the combination of a turbocharger, aftercooler, and SCR using a NERGAS catalyst. It should be noted that the unit is located in a nonattainment area for ozone. Since NO_x is a precursor to ozone, the listed control level is the LAER.

In the SJVUAPCD, NO_x is controlled for a diesel-fired internal combustion engine (208 hp) to 3.04 lb/h (6.63 g/bhp-h) using a turbocharger and an aftercooler for Kearny Ventures, Ltd., located in Lathrop, California.

Alternative NO_x Emissions Reduction Systems. This section discusses two methods of controlling NO_x emissions that include SCR and fuel injection timing retardation.

- **Selective catalytic reduction.** SCR is a post-combustion method of controlling NO_x emissions. This option provides the LAER for the diesel engine. However, SCR is not considered to be a cost-effective NO_x emission control device for the TPP diesel engine due to the emergency status of this generator, which would not be in operation for a significant percentage of the year. Therefore, SCR will not be considered further in this analysis.

- **Fuel injection timing retardation.** Fuel injection timing retardation delays the start of fuel injection in order to reduce the engine's maximum combustion pressure, thereby lowering the combustion temperature. Typically, fuel injection timing on this size unit and service is retarded by 3 to 4 degrees. The maximum amount of retardation possible is controlled by such factors as piston, cylinder, manifold shape and materials, expected unit life, and the impact of modifying the combustion process on other pollutant emissions. Retarding the fuel injection timing can reduce NO_x emissions by 20 to 30 percent, depending upon unit service, size, and design. However, the diesel engine combustion efficiency decreases with an increase in timing retardation, and the emissions of other pollutants, such as CO, VOCs, and particulate matter, subsequently increase.

Conclusions. SCR is not considered to be a cost-effective NO_x reduction alternative for the emergency diesel generator because it will operate 13 hours hours per year for routine testing, and otherwise only under emergency conditions. Therefore, the recommended BACT for the emergency diesel generator is fuel injection timing retardation.

CO and VOC Emission Control. The objective of this analysis is to determine BACT for CO and VOC emissions from the emergency diesel generator.

BACT/LAER Clearinghouse Reviews. A review of the BACT/LAER and CARB BACT Clearinghouses indicates that the most stringent CO emission level for a diesel- fired internal combustion engine is 0.56 lb/hr for OXY NGL, INC located in Johnson Bayou, Louisiana and Archie Crippen, located in Fresno, California. The OXY NGL, INC unit is a 1.4 MMBtu/h emergency diesel generator, and the Archie Crippen unit is a 500-hp diesel fuel internal combustion engine. There are no CO controls on either of these units.

A review of the BACT/LAER and CARB BACT Clearinghouses indicates that the most stringent VOC emission level for a diesel-fired internal combustion engine in this size range is 0.15 lb/h (0.33 g/bhp-h). This unit is a 208-hp internal combustion engine located at Kearny Ventures, Ltd., located in Lathrop, California, in the SJVUAPCD, and it does not have additional add-on controls.

Alternative CO and VOC Emissions Control Systems. CO and VOCs are formed as a result of incomplete oxidation of carbon contained in the fuel. Combustion controls such as high combustion temperatures, adequate excess air, and good fuel/air mixing during combustion will minimize CO and VOC formation. However, lowering combustion temperatures to reduce NO_x formation can be counterproductive with regard to CO and VOC emissions. Because of this inverse relationship, NO_x emissions control technologies must always be considered when determining CO emission controls.

Post-combustion control technologies, such as an oxidation catalyst, may reduce CO and VOC emissions. An oxidation catalyst can be located at the diesel engine exhaust. The reactions and catalyst used are identical to the catalyst oxidation technology previously described for the CTG/HRSG units. However, catalytic oxidation is not considered to be a cost-effective CO and VOC emissions control device for the TPP emergency diesel generator due to the limited operation of the diesel generator. Therefore, catalytic oxidation will not be considered further in this analysis.

Due to the emergency status of the generator and limited hours of operation, BACT for the emergency diesel generator proposed for the TPP is to use good combustion controls.

PM/PM_{10} Emission Control. The objective of this analysis is to determine BACT for PM/PM_{10} emissions from the emergency diesel generator. A review of the U.S. EPA BACT/LAER and CARB Clearinghouses indicates that the most stringent PM emission level for a diesel-fired internal combustion engine (1.5 MMBtu/hr) is 0.23 lb/hr for Saranac Energy Company with combustion control. Since the diesel generator will only be fired under emergency conditions and for 13 hours per year for routine testing, it is anticipated that emission of particulate matter will be minimal. Emissions will be controlled by filtering the source inlet combustion air and ensuring that combustion of the fuel is as complete as possible, which can be accomplished by following the manufacturer's standard operating procedures. Accordingly, BACT for the TPP emergency diesel generator for PM/PM_{10} is assumed to be inlet air filtering and good combustion control.

SO_2 Emission Control. The objective of this analysis is to determine BACT for H_2SO_4 emissions from the emergency diesel generator. The emergency diesel generator proposed for the TPP is required to burn low-sulfur diesel fuel that is not to exceed 0.05 percent sulfur by weight. Furthermore, the diesel generator will only be in operation under emergency conditions and for 13 hours per year for routine testing. Therefore, the recommended BACT for the emergency diesel generator for controlling SO_2 is the use of low-sulfur fuel oil with a maximum content of 0.05 percent by weight.

8.1.3.5 Fugitive Dust Control

Other controls that will be implemented at the TPP site include "best achievable control measures" (BACM) during construction. Fugitive dust control measures stipulated by SJVUAPCD Rules 8010 and 8020 include the following:

- Apply water or chemical stabilizers or other liquids or cover, pave, or compact the site to control dust. Such control(s) will attain a control efficiency of not less than 50 percent (based on data available from efficiencies attained under similar conditions). No BACM used will violate State Water Quality Control Board standards.

- TPP construction activities will not cause visible dust of such opacity as to obscure an observer's view to a degree equal to or greater than 40 percent opacity for a period or periods aggregating more than three minutes in any one hour during construction.

The TPP proposes to use fugitive dust suppression with water to mitigate construction-related emissions. The use of chemical additives is not planned. In accordance with SJVUAPCD Rules, the TPP will submit a Fugitive Dust Control Plan which will reduce projected emissions by 50 percent or more.

8.1.4 Environmental Consequences

This section describes the analyses conducted to assess the potential air quality impacts from the TPP. Emissions estimates are presented for construction and operation of the TPP. Dispersion model selection and setup are also described (i.e., emissions scenarios and release parameters, building wake effects, meteorological data, and receptor locations). Results are presented for the dispersion modeling and the visibility modeling.

8.1.4.1 Construction Emissions

The primary emission sources during construction will be heavy equipment and fugitive dust from disturbed areas as a result of site and transmission line construction. An emission factor of 0.11 ton/month/acre of PM_{10} was used to estimate fugitive dust emissions (MRI, 1996). The emission calculations assume that half of the plant site (4.52 acres) is disturbed during the construction period.

The calculations indicate emissions of 0.18 tons of fugitive PM_{10} per month, assuming a 50 percent control efficiency from frequent water applications on active construction surfaces during hours of construction (or other equivalent dust suppression measures) (See Section 8.1.3.5 for details on fugitive dust control measures). Annual average fugitive dust emissions are estimated to be 0.12 tons/month, the average disturbed land acreage listed above over an annualized period, assuming the same fugitive dust emission factor and control efficiency.

Another source of emissions during construction will be equipment exhaust. Equipment-specific emission factors were used to estimate emissions for all criteria pollutants (SCAQMD, 1993). Table 8.1-11 presents a list of equipment expected to be used during construction, including the estimated numbers of each equipment type that are anticipated to operate during each month of construction. Emissions from equipment will occur over the eight-month construction period.

The worst-case hourly, monthly, and annual emissions are presented in Table 8.1-12. Equipment activity is grouped based on the three areas of construction: the TPP site, the transmission line, and the gas line. Construction emission calculations are provided in Appendix B.

8.1.4.2 Operational Emissions

Estimated annual worst-case emissions for the TPP are presented in Table 8.1-13. These estimates include emissions from the turbine and emergency generator. This section discusses the basis for the annual short-term emission estimates for each source. Emissions and calculations for all scenarios are contained in Appendix B.

Turbine. Two gas turbine operational modes were evaluated to assess worst-case emissions from the gas turbine: base-load and startup/shutdown modes. Hourly emission rates were calculated from equipment vendor estimates for three load conditions (60, 80, and 100 percent) and at a range of three ambient temperatures (15 ºF, 59 ºF, and 115 ºF, at 100, 60, and 30 percent relative humidity, respectively). These are presented in Table 8.1-14. Emission rates include the effect of ammonia injection and SCR emission controls.

Expected event emission rates for NO_x, CO, SO_2, PM_{10}, and VOC during startup and shutdown events are summarized in Table 8.1-15. These emission rates were included in the evaluation of TPP short- and long-term emissions estimates because startup and shutdown events are expected to generate higher emissions than base-load operating conditions. These worst-case emission estimates are included in Appendix B.

To assess worst-case annual emissions, it is estimated that the turbine would experience 250 startups and 250 shutdowns (total time: 208 hours and 20 minutes).

The turbine is assumed to operate at 100 percent load and an annual average temperature of 59 ºF for 8,000 hours per year. The remainder of time is turbine downtime.

Emergency Diesel Generator. The TPP includes a 250-kilowatt emergency diesel generator that will operate for 15 minutes per week for reliability confirmation (13 hours of operation per year). Emissions were estimated based on hourly emission rates provided by the manufacturer for NO_x, CO, PM_{10}, and VOC. SO_2 emissions were estimated using an emission factor for stationary diesel engines from U.S. EPA AP-42 Section 3.3. Annual emissions from the emergency generator included in Table 8.1-13 are based on 13 hours of operation per year. Emissions and calculations for the emergency diesel generator are included in Appendix B.

8.1.4.3 Air Dispersion Modeling

The purpose of the air dispersion modeling analysis is to demonstrate that air emissions from the TPP will not cause or contribute to exceedances of any state or federal air quality standards and will not negatively impact visibility in Class I areas. The modeling addresses emissions from construction activities and routine plant operations. The impacts from construction activities include the generation of fugitive dust and emissions associated with combustion by-products from diesel- and gasoline-fueled equipment. The impacts from routine plant operations include the generation of combustion by-products from the turbines and the emergency generator. Separate modeling analyses were performed for the construction phase and the plant operation sources because they will occur during different time periods. The modeling approach for assessing the TPP impacts is discussed below.

Model and Model Options. The modeling was conducted using the U.S. EPA's Industrial Source Complex (ISC) model (Version 00101) for both construction and turbine emissions (U.S. EPA, 1995a). The short-term model version, ISCST3, was used for modeling concentrations of pollutants that have short-term (i.e., 1-, 3-, 8-, and 24-hour) ambient standards. The ISCST3 model is the most appropriate model because it is a U.S. EPA guideline model for plume dispersion in flat, simple terrain. For pollutants that have both short-term and annual standards (i.e., NO_2, SO_2, and PM_{10}), modeling was conducted using ISCST3 with the PERIOD option to predict impacts with respect to the annual standard. The ISCST3 model was run with the following additional options:

- Final plume rise at all receptors
- Stack-tip downwash
- Buoyancy-induced dispersion
- Calms processing
- Default wind profile exponents
- Default vertical potential temperature gradients
- Rural dispersion coefficients

Building Wake Effects. The effect of building wakes (i.e., downwash) on the stack plumes was evaluated for the routine plant operating emissions (downwash is not applicable to construction activities) in accordance with U.S. EPA's guidance (U.S. EPA, 1985). Direction-specific building data were generated for stacks below good engineering practice stack height using U.S. EPA's Building Profile Input Program (BPIP) Version 98086 (U.S. EPA, 1995b). Five buildings and large pieces of equipment from the proposed TPP layout were included in the analysis (Figure 8.1-5). The results of the BPIP analysis were included in the

ISCST3 input files to assess downwash effects. The ISCST3 model considers direction-specific downwash using both the Huber-Snyder and Schulman-Scire algorithms as evaluated in the BPIP. Input and output files for the BPIP analysis are included in Appendix B.

Meteorological Data. Tracy area meteorological data was obtained from the SJVUAPCD. The surface data were from the Tracy station. Upper air data used to calculate stability and mixing heights were obtained from Stockton. Data for 1997, 1998, and 1999 were used in the modeling analysis.

Receptor Locations. Receptors were placed at offsite locations to evaluate the impacts of the TPP (Figures 8.1-6 and 8.1-7). Receptor spacing was determined according to a receptor's distance from the property boundary. To ensure that the location of highest impact was identified, receptor spacing was closest at the proposed GWF property boundary and increased with distance. Receptors were placed out to 10 kilometers (km) from the property boundary. The following receptor spacing was used in the modeling analysis:

- 25-meter spacing extending from the property boundary out to 100 meters
- 100-meter spacing within 1 km of the property boundary
- 500-meter spacing within 1 to 5 km of the property boundary
- 1,000-meter spacing within 5 to 10 km of the property boundary

The receptor locations were designated using Universal Transverse Mercator (UTM) coordinates. Receptor elevations were obtained from U. S. Geological Survey 7.5-minute electronic data.

Emission Scenarios. The modeling for the TPP required the determination of worst-case emissions scenarios for the following averaging periods and pollutants to demonstrate compliance with ambient air quality standards:

- 1-hour for CO, NO_2, and SO_2
- 3-hour for SO_2
- 8-hour for CO

- 24-hour for PM_{10} and SO_2
- Annual for PM_{10}, NO_2, and SO_2

Construction Impact Modeling. For construction activities, it was assumed that the combustion equipment emissions occur in the area of the construction zone within the TPP property boundary. The worst-case emission scenarios were used to model the construction equipment impacts (see Table 8.1-12).

The construction of the transmission, natural gas, and water lines were not modeled for the following reasons: The onsite gas line is assumed in the general site construction. The emissions from the transmission line construction consist of placing a maximum of 23 poles over 2.8 miles and are considered negligible. The emissions associated with the construction of the 1,470-foot water line are significantly less than those associated with the construction on site. The gas pipeline will be constructed prior to site grading, and the emissions from those construction efforts will not occur simultaneously.

Due to the large amount of construction equipment needed for the TPP, it was necessary to define a representative source or sources. It was assumed that the emissions are uniformly emitted from six point sources within the construction zone. PM_{10} emissions from fugitive dust generated at the project site and laydown areas were modeled as a volume area source. The emission scenarios and release parameters for the construction activities are presented in Table 8.1-16.

The NO_2 1-hour modeling was performed using a version of ISCST3 that allows for the inclusion of the ozone limiting method (OLM). The OLM offers a more realistic method of calculating concentrations of NO_2. During the combustion of natural gas, approximately 10 percent of the stack emissions are NO_2. The remaining stack gas is released as NO. In the atmosphere, NO chemically reacts with ambient concentrations of ozone to form NO_2. The OLM model calculates NO_2 concentrations based on the ambient ozone concentrations using this principle.

Turbine Impact Screening Modeling. Screening modeling was performed to determine which turbine operating modes (i.e., load level, ambient temperature) produced "worst-case" impacts for each pollutant and averaging time. The ISCST3 model (Version 00101) was used for screening modeling. For the screening analysis, the model was configured with 1997–1999 meteorological data from Tracy using the building wake information and the receptor grid previously described.

The model simulated natural gas combustion emissions from two 17-foot-diameter (5.18-m), 100-foot-tall (30.48-m) stacks. The two sources were modeled as point sources at the proposed locations. The stack parameters for each operating mode are shown in Table 8.1-17.

For analysis of worst-case, short-term impacts (1-, 3-, 8- and 24-hour averages), the turbine emissions were modeled with 20 minutes of startup emissions and the remainder of the time at emissions corresponding to the load and ambient temperature for that scenario. Emergency generator emissions were included in each of the four short-term averaging periods as well.

Annual average impacts assume stack parameters for turbine operation at 100 percent load and 59 °F ambient temperature. These conditions represent routine, sustained operation. Annual emission estimates applied to these dispersion impacts include emissions for 250 startups and 250 shutdowns, as discussed in Section 8.1.4.2.

Refined Modeling. Refined modeling was performed to identify offsite criteria pollutant impacts from operational emissions of the proposed project. The modeling was performed as previously described. However, in addition to the turbine, the emergency generator was also included in the refined modeling analysis.

The emergency generator was included with the turbines for the 1-, 3-, 8-, and 24-hour and annual averaging period. The emergency generator is assumed to operate 13 hours per year, and only when the turbines are running at full load.

Fumigation Analysis. Fumigation occurs when a plume that was originally emitted into a stable layer of air is mixed rapidly to ground level when unstable air below the plume reaches plume level. Fumigation can cause very high ground-level concentrations.

Fumigation can occur during the breakup of the nocturnal radiation inversion by solar warming of the ground surface (inversion breakup fumigation). Such conditions are short-lived and are typically compared only with 1-hour standards. A fumigation analysis was performed using the U.S. EPA SCREEN3 model (Version 96043).

8.1.4.4 Compliance with Ambient Air Quality Standards

This section provides a comparison of air quality impacts associated with the TPP emissions to the applicable short-term and long-term air quality standards. The impacts from construction activities and routine plant operations are evaluated separately because they will occur during different time periods and represent different sources. ISCST3 model results for each averaging time were added to the maximum background concentrations obtained from the most recent six years of air quality data (i.e., 1995–2000). These background air quality data are presented in Section 8.1.2.2.

The maximum air quality impacts are compared with the most stringent state or federal standards. Tables 8.1-18 and 8.1-19 summarize modeling results for construction and operation, respectively.

Construction Activities. Construction emissions are of a temporary nature and will not coincide with emissions from plant operations. The maximum air quality impacts from construction activities were predicted to occur along the southern boundary except for PM_{10}, where the maximum concentrations occur along the north and northeastern boundaries. All pollutants except PM_{10} are predicted to not cause an exceedance of air quality standards. Background concentrations of PM_{10} already exceed the SAAQS in the area, and the predicted 24-hour and PM_{10} impacts are potentially significant. However, these construction emissions are substantially lessened and will not significantly contribute to the existing violation. Construction mitigation measures, described in Section 8.1.3, will be used to minimize impacts from temporary construction emissions. Construction modeling outputs are included in Appendix B.

Routine Plant Operations. Maximum modeled impacts due to plant operation emissions would not cause a violation of any federal or state standards and would not significantly contribute to the existing violations of the PM_{10} standards. Fumigation impacts are all below applicable short-term air quality standards. The fumigation impacts are summarized in Table 8.1-20.

Impacts for Nonattainment Pollutants and their Precursors. TPP impacts for the nonattainment pollutants (PM_{10} and ozone) and their precursors (NO_x, VOC, and SO_2) will be mitigated by emission offsets. The offsets have not been accounted for in the modeled impacts noted above. Thus, the TPP's modeled impacts significantly overestimate actual project impacts, because they do not account for the effect of removing PM_{10}, NO_x, VOC, and SO_2 from the San Joaquin Valley airshed.

8.1.5 Commissioning Activities

Startup and commissioning for the TPP CTGs is estimated to occur over an approximate six-week duration from first fire to full load commercial operation. As a worst-case scenario, it is assumed that the TPP will perform startup and commissioning on both of the units in parallel. In reality, however, each CTG will need to be commissioned on a slightly staggered schedule to best utilize onsite personnel and resources.

The CTGs will be commissioned and tested based on the following activities associated with operation of the gas turbine. The scheduled duration listed below is for each gas turbine generator unit.

Commissioning Activity	Calendar Duration[1]	Unit Load
First Fire	3 days	60%
Full Speed No Load Operation	4 days	60%
Synchronization and Load Test	3 days	60%–100%
Outage/Water Wash	3 days	N/A
Synchronization and Loaded Incrementally	2 days	40%–100%
Operation with SCR and Catalyst/CEM Certification	4 days	40%–100%
Final Plant Tuning	2 day	60%–100%
Performance Test	2 days	100%
Reliability Run	7 days	95%

[1]Each calendar day is 8 hours

The owner will minimize emissions of CO, NO_x, and other pollutants by limiting the test time of each commissioning activity to the shortest duration feasible. The NO_x and CO catalyst will be installed at the earliest possible time in the testing cycle, consistent with manufacturer's recommendations.

Prior to initial startup of each CTG, a continuous emissions monitoring (CEM) system will be installed, tested, and calibrated to measure criteria pollutants during startup and commissioning.

The CEM will provide monitoring and recording on three-minute averages of fuel flow rates, firing hours, stack gas NO_x, stack gas CO, and stack gas oxygen concentrations. The owner/operator will use District-approved methods to calculate heat input rates, mass emissions, and concentrations of criteria pollutant emissions. The CEM type, specifications, and stack location will be in accordance with the District requirements.

The operation of the CTG without abatement will be limited to those commissioning activities whereby the SCR and CO catalyst must not be installed.

Prior to the end of the commissioning period, the owner/operator will conduct a District-approved source test using external CEMs to determine compliance of the emission limits specified during commissioning. The source test will determine NO_x, CO, and VOC emissions during startup and shutdown of the gas turbines. The VOC emissions will be analyzed for methane and ethane to account for the presence of unburned natural gas. Thirty calendar days before the execution of the source tests, the owner/operator will submit to the District and the CEC Compliance Program Manager (CPM) a detailed source test plan designed to satisfy the requirements of this condition. The District and the CEC CPM will notify the owner/operator of any necessary modifications to the plan within 30 working days of receipt of the plan; otherwise, the plan will be deemed approved. The owner/operator will notify the District and the CEC CPM within the seven working days prior to the planned source testing date. Source test results will be submitted to the District and the CEC CPM within 30 days of the source testing date.

The emissions and results of the commissioning modeling analysis are presented in Table 8.1-21. The analysis is based on both CTGs being commissioned at the same time, with short-term emission estimates that reflect higher commissioning emissions. These estimates are not precise, since actual commissioning data from GE 7EA CTGs are not available. The analysis was performed only for short-term averaging times. In addition, because emissions of PM_{10} and SO_2 are not expected to be greater during commissioning than during normal operations, no commissioning modeling was performed. Please refer to Table 8.1-19 for short-term impacts from the turbines.

8.1.6 Cumulative Impacts Modeling

CEC requirements specify that an analysis may be required to determine the cumulative impacts of the TPP and other projects within a six-mile radius that have received construction permits but are not yet operational or that are in the permitting process. The cumulative impact analysis will assess whether estimated emissions concentrations may cause or contribute to a violation of any ambient air quality standard. As part of the expedited permitting process, a cumulative analysis of the emissions of the TPP and of surrounding projects was performed. The only project identified within a six-mile radius of the TPP is a confidential power project.

Detailed data from the confidential power project has been obtained and were used to model their impacts using the ISCST3 model. The modeling was executed using the 1997 through 1999 Tracy meteorological data obtained from the SJVUAPCD and the options previously identified for project modeling. TPP sources were modeled as a separate group in order to isolate and compare the TPP impacts relative to the impacts from the confidential power project. For all sources included in the cumulative modeling, the typical (annual) operating mode was assumed.

Stack parameters and emission rates are summarized in Tables 8.1-22 and 8.1-23, respectively. Sources such as cooling towers and emergency equipment were not included in the cumulative modeling analysis. In addition, modeled emissions were based on annual average missions. The maximum impact for these types of sources typically occur near the facility fenceline and are not apt to contribute to the cumulative impact.

The results of the cumulative analysis are presented in Table 8.1-24. There are no applicable thresholds for comparison, thus the results presented in Table 8.1-24 are for informational purposes only.

8.1.7 Emission Offsets

8.1.7.1 Emission Offset Requirements

SJVUAPCD rules require that emissions be offset by emission reductions. These offset requirements are implemented under SJVUAPCD Rule 2201. Table 8.1-25 summarizes the offset requirements specified by Rule 2201 that are applicable to the TPP. As shown in Table 8.1-25, the TPP will trigger Rule 2201 offset requirements for NO_x, VOC, PM_{10}, and SO_2 emissions. CO emissions from the TPP will also exceed the NSR offset threshold. Rule 2201, Section 4.2.1.1 exempts the TPP from CO offset requirements, because air quality modeling results (see Section 8.1.4) indicate that the TPP will not cause or contribute to a violation of any applicable California or federal ambient air quality standard. Nevertheless, GWF intends to provide offsets for TPP CO emissions as an additional air quality benefit of the project.

Rule 2201 also requires that emission reduction credits (ERCs) for offsite areas and within 15 miles must be provided at a ratio of 1.2 to 1. For areas outside of the 15 miles, ERCs must be provided at a ratio of 1.5 to 1.

In addition to the required SO_2 emission offsets indicated in Table 8.1-27, the TPP is subject to the Clean Air Act Title IV provisions that will require the TPP to hold annual SO_2 allowances for each ton of SO_2 emitted after 2000. TPP will comply with applicable Title IV requirements prior to commencement of operation.

8.1.7.2 Emission Offset Supply

The SJVAPCD maintains a formal ERC banking system pursuant to Rules 2301 and 2302. For an ERC to be deposited in the bank, the depositor must demonstrate that the ERCs meet applicable federal Emission Trading Policy criteria (i.e., ERCs are real, federally enforceable, quantifiable, verifiable, and surplus). All ERCs currently in the bank that were deposited after the date of adoption of Rules 2201, 2301, and 2302 can therefore be assumed to comply with applicable federal emissions trading criteria. It is the intention of the TPP to use only ERCs that satisfy these federal emissions trading criteria.

GWF has acquired or is in the process of acquiring ERC certificates from SJVUAPCD ERC holders that meet the stated ERC criteria. A comparison of the TPP offset requirements and the ERCs (either acquired by GWF or in the process of being transferred to GWF) are shown in Table 8.1-26. Table 8.1-26 includes the application of either the 1.2 to 1 or 1.5 to 1 ratio to each ERC certificate, as applicable, in order to calculate the emission offsets. Appendix B contains detailed information on these emission offset calculations.

Table 8.1-28 shows that the indicated ERC certificates will cover the TPP's emission offset requirements, except for 17.97 tons per year of NO_x during the first and fourth quarters, and 0.75 tons per year of CO during the first quarter. The SJVUAPCD has enough available ERCs on deposit for these pollutants to cover the TPP's remaining emission offset requirements.

GWF is currently negotiating with several ERC holders to obtain the remaining NO_x ERCs needed. Appendix B contains documentation of these current negotiations. Additional ERC information will be submitted under confidential cover, including the required ERC certificates. Because of the low quantity of PM_{10} ERCs available, it is proposed that the TPP partially offset PM_{10} emissions using SO_2 ERCs at an interpollutant offset ratio of 2.5 to 1. Justification for this ratio is provided in Appendix B.

8.1.8 Compliance with Laws, Ordinances, Regulations, and Standards

Applicable LORS are summarized in Section 8.1.1. This section presents the applicable air quality permits or approvals required for the TPP (Table 8.1-27) and describes how the TPP will comply with applicable air quality LORS (Table 8.1-28). In order to demonstrate compliance with several LORS, the GWF will install and operate a CEM system. The CEM system is described in detail in Section 2.2.11 of this AFC.

In summary, the TPP will comply with all applicable LORS, conform to BACT requirements, and will not interfere with attainment or maintenance of NAAQS or SAAQS. In addition, the TPP emissions (NO_x, VOCs, PM_{10}, and CO) will be fully offset.

8.1.9 Proposed Conditions of Certification

Proposed conditions of certification are contained in Appendix K. These conditions are proposed to ensure compliance with applicable LORS and/or to reduce potentially significant impacts to less-than-significant levels.

8.1.10 Agency Contacts

The air quality agencies with authority over construction and operation of the TPP are shown below:

Agency	Contact/Title	Telephone
San Joaquin Valley Unified Air Pollution Control District	Jim Swaney Permit Services Manager Northern Zone 4230 Kiernan Avenue Modesto, CA 95356	(209) 557-6400
U.S. EPA, Region IX	Matthew Haber Chief, New Source Section U.S. EPA Region IX 75 Hawthorne Street San Francisco, CA 94105	(415) 744-1254

8.1.11 References

CARB, 2001. California Air Quality Data Statistics, 1989-1998 Data, http://www.arb.ca.gov, Air Quality Data Branch, California Air Resources Board, Sacramento, California. December.

CARB, 1999. Guidance for Power Plant Siting and Best Available Control Technology. California Energy Commission. June.

MRI, 1996. Improvement of Specific Emission Factors (BACM Project No. 1), Final Report. Prepared by Midwest Research Institute for South Coast AQMD. March 29.

National Climatic Data Center (NCDC), 2001. Internet site of climate data (http://www.ncdc.noaa.gov/ol/climate/online/ccd/avgrh.html)

South Coast Air Quality Management District (SCAQMD), 1993. *CEQA Air Quality Handbook.* April 1993.

U.S. EPA, 1985. *Guideline for Determination of Good Engineering Stack Height* (Technical Support Document for the Stack Height Regulation) (Revised), EPA-450/4-80-023R. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. June.

U.S. EPA, 1995a. *User's Guide for the Industrial Source Complex (ISC3) Dispersion Models*, EPA-454/B-95-003a, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. September.

U.S. EPA, 1995b. *User's Guide to the Building Profile Input Program* (Revised), EPA-454/R-93-038, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. February.

TABLES

Table 8.1-1
Relevant Federal and California Ambient Air Quality Standards

Pollutant	Averaging Time	California AAQS[a,c]	Federal AAQS[b,c] Primary	Federal AAQS[b,c] Secondary
Ozone (O_3)	1-hour	0.09 ppm (180 μg/m^3)	0.12 ppm (235 μg/m^3)	Same as primary standard
	8-hour[d]		0.08 ppm (157 μg/m^3)	
Carbon Monoxide (CO)	8-hour	9 ppm (10 mg/m^3)	9 ppm (10 mg/m^3)	
	1-hour	20 ppm (23 mg/m^3)	35 ppm (40 mg/m^3)	
Nitrogen Dioxide (NO_2)[e]	Annual (Arithmetic Mean)		0.053 ppm (100 μg/m^3)	Same as primary standard
	1-hour	0.25 ppm (470 μg/m^3)		
Sulfur Dioxide (SO_2)	Annual (Arithmetic Mean)		0.03 ppm (80 μg/m^3)	
	24-hour	0.04 ppm[f] (105 μg/m^3)	0.14 ppm (365 μg/m^3)	
	3-hour			0.05 ppm (1300 μg/m^3)
	1-hour	0.25 ppm (655 μg/m^3)		
Respirable Particulate Matter (PM_{10})	Annual (Geometric Mean)	30 μg/m^3		Same as primary standard
	24-hour	50 μg/m^3	150 μg/m^3	
	Annual (Arithmetic Mean)		50 μg/m^3	
Fine Particulate Matter ($PM_{2.5}$)[d]	24-hour	No separate state standard	65 μg/m^3	Same as primary standard
	Annual (Arithmetic Mean)		15 μg/m^3	
Visibility Reducing Particles	1 observation	See footnote g.	No federal standard	No federal standard

Table 8.1-1 (continued)
Relevant Federal and California Ambient Air Quality Standards

[a] Title 17, California Code of Regulations, California AAQS for ozone (as volatile organic compounds), carbon monoxide, sulfur dioxide (1-hour), nitrogen dioxide, and particulate matter (PM_{10}), are values that are not to be exceeded. The visibility standard is not to be equaled or exceeded.

[b] 40 CFR 50. National AAQS, other than those for ozone and based on annual averages, are not to be exceeded more than once a year. The ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above the standard is equal to or less than one.

[c] Concentrations are expressed first in units in which they were promulgated. Equivalent units are given in parentheses and based on a reference temperature of 25 degrees Celsius and a reference pressure of 760 millimeters of mercury. All measurements of air quality area to be corrected to a reference temperature of 25 degrees Celsius and a reference pressure of 760 millimeters of mercury (1,013.2 millibar); ppm in this table refers to ppm by volume, or micromoles of pollutant per mole of gas.

[d] New federal 8-hour ozone and fine particulate matter ($PM_{2.5}$) standards were promulgated by U.S. EPA on July 18, 1997. The federal 1-hour ozone standard continues to apply in areas that violated the standard.

[e] Nitrogen dioxide (NO_2) is the compound regulated as a criteria pollutant; however, emissions are usually based on the sum of all oxides of nitrogen (NO_x).

[f] At locations where the state standards for ozone and/or PM_{10} are violated. National standards apply elsewhere.

[g] In sufficient amount to reduce the prevailing visibility to less than 10 miles when the relative humidity is less that 70%. “Prevailing visibility” is defined as the greatest visibility, which is attained or surpassed around at least half of the horizon circle, but not necessarily in continuous sectors.

AAQS =Ambient Air Quality Standard
mg/m3 =milligrams per cubic meter
μg/m3 =micrograms per cubic meter

Table 8.1-2
Federal and State Attainment Status for San Joaquin County[a]

Pollutant	Federal Attainment Status	State Attainment Status
Ozone	Serious Nonattainment	Severe Nonattainment
CO	Unclassified/Attainment	Attainment
NO_2	Unclassified/Attainment	Attainment
SO_2	Unclassified	Attainment
PM_{10}	Serious Nonattainment	Nonattainment
Lead	No Designation	Attainment

[a] Attainment status obtained from 40 CFR 81 and SJVUAPCD website (www.valleyair.org).

Table 8.1-3
Temperature and Precipitation Data at the Tracy Carbona Station, San Joaquin, California

Month	Average Temperatures (°F)[a] Low	Average Temperatures (°F)[a] High	Relative Humidity (%)[b] Morning	Relative Humidity (%)[b] Afternoon	Average Precipitation[a] (inches)
January	36.7	54.1	90	71	1.93
February	40	61	88	62	1.71
March	42.5	66.7	84	50	1.41
April	45.6	73.4	79	41	0.84
May	50	80.6	75	34	0.5
June	54.8	88.1	71	29	0.09
July	56.8	93.8	67	27	0.03
August	55.6	92.4	68	29	0.09
September	53.9	87.9	71	31	0.24
October	48.7	78.6	75	38	0.53
November	42.1	64.9	83	57	1.13
December	36.6	54.7	91	71	1.49
Annual Average	**46.9**	**74.7**	**78**	**45**	**9.99**

a. National Weather Service website, 2001. Average temperature and precipitation data represent 1948–2000.
b. National Climatic Data Center website, 2001.

Table 8.1-4
Summary of Ambient Data for Ozone

	1995	1996	1997	1998	1999	2000
	Maximum 1-Hour Average Concentration (ppm)					
Tracy - Patterson Pass Road[a,b]	0.124	0.140	0.119	0.116	0.132	0.122
Stockton – E. Mariposa[a,b]	0.134	0.105	0.101	0.123	0.143	0.108
Stockton - Hazelton Street[a,b]	0.125	0.120	0.102	0.126	0.144	0.107
	Maximum 8-Hour Average Concentration (ppm)					
Tracy - Patterson Pass Road[c]	0.098	0.096	0.099	0.094	0.113	0.094
Stockton – E. Mariposa[c]	0.107	0.083	0.083	0.099	0.093	0.084
Stockton - Hazelton Street[c]	0.103	0.094	0.082	0.100	0.108	0.08

[a] Maximum 1-hr average concentrations exceed the state ozone ambient air quality standard of 0.09 ppm (180 $\mu g/m^3$).
[b] Maximum 1-hr average concentrations exceed the federal ozone ambient air quality standard of 0.12 ppm (235 $\mu g/m^3$).
[c] Maximum 8-hr average concentrations exceed the federal ozone ambient air quality standard of 0.08 ppm (157 $\mu g/m^3$).
$\mu g/m^3$ =micrograms per cubic meter
ppm =parts per million

Table 8.1-5
Summary of Ambient Data for PM_{10}

	1995	1996	1997	1998	1999	2000
	Maximum 24-Hour Average Concentration (μg/m³)					
Tracy - Patterson Pass Road	—	—	—	—	—	—
Stockton Wagner - Holt School[a,b]	—	117.0	130.0	99.0	118.0	104.0
Stockton - Hazelton Street[a,b]	109.0	127.0	98.0	106.0	150.0	91.0
	Annual Average Concentration (μg/m³)					
Tracy - Patterson Pass Road	—	—	—	—	—	—
Stockton Wagner - Holt School (State Average)	—	22.5	22.5	20.8	21.6	24.8
Stockton Wagner - Holt School (Nat'l Average)	—	29.2	26.1	25.5	22.0	29.3
Stockton - Hazelton Street (State Average)[c,d]	23.8	23.7	26.8	24.4	30.2	29.1
Stockton - Hazelton Street (Nat'l Average)[c,d]	24.4	27.4	29.7	29.1	36.4	32.2

[a] Maximum 24-hr average concentrations exceed the state PM_{10} ambient air quality standard of 50 μg/m³.
[b] Maximum 24-hr average concentrations do not exceed the federal PM_{10} ambient air quality standard of 150 μg/m³.
[c] Maximum annual average concentrations exceed the state PM_{10} ambient air quality standard of 30 μg/m³.
[d] Maximum annual average concentrations exceed the federal PM_{10} ambient air quality standard of 50 μg/m³.

— = data not available.
μg/m³ = micrograms per cubic meter
ppm = parts per million

Table 8.1-6
Summary of Ambient Data for Carbon Monoxide

	1995	1996	1997	1998	1999	2000
	Maximum 1-Hour Average Concentration (ppm)					
Tracy - Patterson Pass Road	—	—	—	—	—	—
Stockton Claremont[a]	8.7	11.0	6.3	10.2	11.3	8.5
Stockton - Hazelton Street[a]	10.3	9.4	6.1	7.3	8.3	5.8
	Maximum 8-Hour Average Concentration (ppm)					
Tracy - Patterson Pass Road	—	—	—	—	—	—
Stockton Claremont	6.18	7.56	4.24	7.90	7.75	4.68
Stockton - Hazelton Street	4.50	6.41	3.60	7.18	5.34	3.59

[a] Maximum 1-hr average concentrations do not exceed the state or federal PM_{10} ambient air quality standards of 20.0 ppm (23 mg/m^3) and 35 ppm (40 mg/m^3), respectively.
[b] Maximum 8-hour average concentrations do not exceed the state or federal PM_{10} ambient air quality standard of 9.0 ppm (10 mg/m^3).
— = data not available
µg/m3 = micrograms per cubic meter
ppm = parts per million

Table 8.1-7
Summary of Ambient Data for Nitrogen Dioxide

	1995	1996	1997	1998	1999	2000
	Maximum 1-Hour Average Concentration (ppm)					
Tracy - Patterson Pass Road	0.068	0.061	0.060	0.079	0.074	0.068
Stockton - E. Mariposa	—	—	—	—	—	—
Stockton - Hazelton Street	0.119	0.088	0.090	0.102	0.106	0.099
	Annual Average Concentration (ppm)					
Tracy - Patterson Pass Road	—	0.013	0.012	0.013	0.015	0.014
Stockton - E. Mariposa	—	—	—	—	—	—
Stockton - Hazelton Street	0.022	0.023	0.022	0.023	0.024	0.02

[a] Maximum 1-hr average concentrations do not exceed the state NO_2 ambient air quality standard of 0.25 ppm (470 µg/m^3).
[b] Annual average concentrations do not exceed the state NO_2 ambient air quality standard of 0.053 ppm (100 µg/m^3).
— = data not available
µg/m^3 = micrograms per cubic meter
ppm = parts per million

Table 8.1-8
Summary of Ambient Data for Sulfur Dioxide

	1995	1996	1997	1998	1999	2000
	Maximum 1-Hour Average Concentration (ppm)[a]					
Concord - Treat Boulevard	0.033	0.019	0.038	0.049	0.048	0.015
Bethel Island Road	0.015	0.014	0.015	0.028	0.03	0.018
North Highlands (Sacramento)	0.003	0.014	0.038	0.013	0.01	0.013
	Maximum 24-Average Concentration (ppm)					
Concord - Treat Boulevard	0.0072	0.005	0.0078	0.0075	0.012	0.005
Bethel Island Road	0.006	0.007	0.007	0.009	0.008	0.008
North Highlands (Sacramento)	0.0009	0.003	0.004	0.005	0.004	0.005
	Annual Average Concentration (ppm)					
Concord - Treat Boulevard	0.0018	0.0016	0.0015	0.0019	0.002	0.002
Bethel Island Road	0.001	0.001	0.002	0.002	0.001	0.001
North Highlands (Sacramento)	0	0.001	0.0008	0.001	0.001	0.001

[a] Maximum 1-hr average SO_2 concentrations do not exceed the state ambient air quality standard of 0.25 ppm (655 μg/m^3).

[b] Maximuml 24-hr SO_2 concentrations do not exceed the state ambient air quality standard of 0.04 ppm (105 μg/m^3).

[c] Maximum annual average SO_2 concentrations do not exceed the federal ambient air quality standard of 0.030 ppm (80 μg/m^3).

— = data not available
μg/m^3 = micrograms per cubic meter
ppm = parts per million

Table 8.1-9
Emission Rates for GE PG7121 (EA) Unit Firing Natural Gas

Emission Parameter	GE PG7121 (EA) CTG[a] (uncontrolled)
NO_x, ppmvd at 15% O_2	9
NO_x, lb/h	33.1
NO_x, lb/MMBtu (HHV)	0.0334
CO, ppmvd at 15% O_2	25.2
CO, lb/h	54.6
CO, lb/MMBtu (HHV)	0.0551
VOC, ppmvd at 15% O_2	1.52
VOC, lb/h as CH_4	1.9
VOC, lb/MMBtu (HHV)	0.0019
PM/PM_{10}, lb/h (front catch only)	5
PM/PM_{10}, lb/h (front and back half)	10
PM/PM_{10}, lb/MMBtu (front catch only)	0.0057
PM/PM_{10}, lb/MMBtu (front and back half)	0.0112

[a] Total emissions are based on 8,000 hours per year firing natural gas at 100% of base load with the evaporative cooler in operation and at an ambient temperature of 59 °F at CTG exhaust (prior to air dilution system).

O_2 = oxygen
HHV = higher heating valve
lb/h = pounds per hour
CH_4 = methane
MMBtu = million British thermal units
ppmvd = parts per million by volume dry

Table 8.1-10
Project Economic Evaluation Criteria

Economic Parameters	Value
Contingency, percent	20
Real Interest Rate, percent	10
Economic Life, years	3
Capital Recovery Factor (3 years)	0.4021
Labor Cost, \$/man-hr	40
Energy Cost, \$/kWhr (2000)	0.10
Catalyst Life Guarantee, years	3
Sales Tax,%	7.5

kWhr = kilowatt hour
man-hr = man hour

Table 8.1-11
Estimated Equipment Construction Schedule

Equipment Type	Month 1	2	3	4	5	6	7	8	9	Time Period Per Month	Work Day	Actual % Use
Sitework (Earthwork and Civil)												
Backhoe, 1.0 Cyd.	1	1	1	1	1	1				21.73	20	35
Front End Loader, 2 Cyd.	1	1	1	1	1	1				21.73	20	35
Grader, 200-Hp 14 Ft.	1	1	1	1	1	1	1			21.73	20	25
Vibratory Plate (hand-held)	1	1	1	1	1	1	1			21.73	20	30
Rammer/Jumping Jack (hand-held)	1	1	1	1	1	1	1			21.73	20	30
Riding Vibratory Compactor		1	1							21.73	20	20
Asphalt Paver									1	21.73	20	60
Asphalt Cutter/Grinder									1	21.73	20	60
Asphalt Compactor, Tandem Steel Drum Roller									1	21.73	20	60
Erection Support Equipment												
Air Compressor, 185 CFM	1	1	1	1	1	1	1	1	1	21.73	20	75
Air Compressor, 185 CFM			1	1	1	1				21.73	20	75
Concrete Pump	1	1	1	1						21.73	20	90
Scissors Lift		1	1	1						21.73	20	40
JLG 60 Ft		1	1	1	1	1	1	1		21.73	20	50
JLG 60 Ft			1	1	1	1	1			21.73	20	50
JLG 60 Ft				1	1	1	1			21.73	20	50
Forklift Extended Boom	1	1	1	1	1	1	1	1	1	21.73	20	25
Crane 110 Ton			1	1	1	1				21.73	20	40
Hydraulic Truck Crane 55 Ton	1	1	1	1	1	1	1	1		21.73	20	60
Hydraulic Truck Crane 55 Ton		1	1	1	1	1				21.73	20	60
Hydraulic Truck Crane 35 Ton		1	1	1	1	1	1	1		21.73	20	60
Hydraulic Truck Crane 22 Ton	1	1	1	1	1	1	1	1	1	21.73	20	60
Hydraulic Truck Crane 22 Ton					1					21.73	20	70
7,000-Watt Portable Generator	1	1	1	1	1	1				21.73	20	40
Welder - Miller 400d		1	1	1	1	1	1	1	1	21.73	20	70
Welder - Miller 400d			1	1	1	1	1			21.73	20	70
Highway Tractor		1	1	1	1	1	1			21.73	20	30
Flat Bed Truck w/ Rails		1	1	1	1	1	1			21.73	20	40
Water Truck	1	1	1	1	1	1				21.73	20	50

Table 8.1-12
Estimated Criteria Pollutant Emissions from Construction Equipment

	VOC	CO	NO_x	SO_x	PM_{10}
Main Site and Switchyard Construction					
Worst-Case Hourly Emissions (lbs/hr)	2.5	35.9	27.7	2.7	1.9
Worst-Case Monthly Emissions (lbs/month)[a]	1,279	18,435	13,523	1,299	973
Worst-Case Annual Emissions (tons/yr)[b]	4.0	59.2	43.7	4.2	3.1

[a] Using the estimated construction schedule, monthly emissions were estimated for each piece of equipment assuming 21.73 days per month at 20 hours per day (two 10-hour shifts per day).

[b] Worst-case annual emissions were estimated by summing emissions for each 9-month period and dividing by 12.

Table 8.1-13
TPP Worst-Case Annual Emissions

Pollutant	Emissions (tons/year)[a,b]
VOC	12.9
CO	71.6
NO_x	153.5
SO_2	4.4[d]
PM_{10}	83.7[c,d]

[a] Turbine and emergency generator emissions included.

[b] Turbine 250 startup and shutdown events and 8,000 hours of time operating at 100% load at an annual average condition of 59 °F. Emergency generator rates consider 15 minutes per week.

[c] Turbine PM_{10} emissions are calculated from emissions rates provided by equipment vendors. These emissions include both filterable (front-half) and condensable (back-half) particulates.

[d] Condensable PM_{10} and SO_2 reflect a maximum fuel sulfur content of 0.25 grains per 100 standard cubic feet.

Table 8.1-14
Criteria Pollutant Emission Rates for the Turbine with SCR and Oxidation Catalyst During Normal Operation (pounds per hour)

CTG Load	Pollutant	Ambient Temperature 15 ºF	59 ºF	115 ºF
	VOC	1.72	1.59	1.46
	CO	8.36	7.64	6.83
	NO_x	20.17	18.37	16.63
	SO_2	0.61	0.55	0.50
100%	PM_{10}	10.4	10.3	10.3
	VOC	1.60	1.30	1.20
	CO	8.16	6.26	5.64
	NO_x	16.71	15.51	14.32
	SO_2	0.50	0.46	0.43
80%	PM_{10}	10.3	10.3	10.3
	VOC	1.35	1.10	1.65
	CO	7.10	5.31	8.23
	NO_x	14.32	13.39	12.38
	SO_2	0.43	0.40	0.37
60%	PM_{10}	10.3	10.3	10.2

Table 8.1-15
Criteria Pollutant Emission Rates for the TPP Turbine During Startup and Shutdown

Pollutant	Startup 20 Minutes (Total lb/event)	Shutdown 30 Minutes (Total lb/event)
NO_x	13	13
CO	21	21
SO_2	0.08	0.08
PM_{10}	2.6	2.6

Table 8.1-16
TPP Construction Release Parameters

	Stack Characteristics (for the Construction Zone)			
Emissions Scenario	**Stack Height (m)**	**Stack Diameter (m)**	**Exhaust Temp (°K)**	**Exhaust Velocity (m/s)**
Construction Equipment[a]	3.05	0.10	366.5	40

Emissions Scenario	**Release Height (m)**	**Initial Horizontal Dimension (m)**	**Initial Vertical Dimension (m)**
Fugitive Dust[b]	3.05	31.02	2.83

[a] The data shown represent the surrogate stack and release parameters for six release points.

[b] Fugitive dust emissions modeled as a single volume source.

Table 8.1-17
Stack Parameters

CTG Load Level (% of Base Load)	Turbines								
	100%	**80%**	**60%**	**100%**	**80%**	**60%**	**100%**	**80%**	**60%**
Ambient Temperature °F	115	115	115	59	59	59	15	15	15
Stack Exit Temperature, °K	727.6	727.6	727.6	727.6	727.6	727.6	727.6	727.6	727.6
Stack Exit Velocity, m/s	34.75	30.5	27.43	36.27	31.1	27.74	37.49	31.7	28.0

m = meter
K = Kelvin
m/s = meters per second

Table 8.1-18
TPP ISCST3 Modeling Results – Construction Activities

Pollutant	Averaging Period	Maximum Modeled Impact ($\mu g/m^3$)	Background ($\mu g/m^3$)	Total Predicted Concentration ($\mu g/m^3$)	Lowest AAQS ($\mu g/m^3$)	UTM Coordinates East (m)	UTM Coordinates North (m)
CO	1-hour	2,884	12,941	15,825	23,000	633,050	4,174,475
	8-hour	1,552	9,047	10,599	10,000	633,050	4,174,450
NO_2	1-hour	224[a]	224	448	470	632,918	4,174,605
	Annual	29.1	45	74.1	100	633,112	4,174,483
PM_{10}	24-hour	34.4	150	184	50	632,918	4,174,605
	Annual	2.86	36.4	39.3	30	633,112	4,174,482
SO_2	1-hour	218	128	346	655	633,050	4,174,475
	3-hour	136.2	--	136.2	1,300	633,075	4,174,475
	24-hour	35.9	31	67	105	633,111	4,174,482
	Annual	2.77	5.2	8	80	633,112	4,174,482

[a] Results based on OLM applied with maximum ambient ozone concentration of 287.5 $\mu g/m^3$.

AAQS = most stringent ambient air quality standard for the averaging period
OLM = ozone limiting method
m = meters
$\mu g/m^3$ = micrograms per cubic meter
CO = carbon monoxide
NO_2 = nitrogen dioxide
PM_{10} = particulate matter less than or equal to 10 micrometers in diameter
SO_2 = sulfur dioxide
UTM = Universal Transverse Mercator

Table 8.1-19
TPP ISCST3 Modeling Results – Routine Plant Operations

Pollutant	Averaging Period	Maximum Impact ($\mu g/m^3$)[a]	Background ($\mu g/m^3$)[b]	Total Predicted Concentration ($\mu g/m^3$)	Lowest AAQS ($\mu g/m^3$)	UTM Coordinates East (m)	UTM Coordinates North (m)
Annual Impacts –Turbine and Emergency Generator							
NO_2	Annual	0.053	45	45	100	621,200	4,176,300
PM_{10}	Annual	0.03	36.4	36.4	30	621,200	4,176,300
SO_2	Annual	0.004	5.2	5.2	80	632,975	4,174,550
Short-Term Impacts –Turbine and Emergency Generator							
CO	1-hour	46.9	12,941	12,988	23,000	632,972	4,174,559
	8-hour	6.81	9,047	9,054	10,000	632,200	4,171,400
NO_2	1-hour	212	224	436	470	632,972	4,174,559
PM_{10}	24-hour	2.11	150	152	50	632,200	4,171,400
SO_2	1-hour	34	128	162	655	632,972	4,174,559
	3-hour	8.1	--	8.1	1,300	632,972	4,174,559
	24-hour	0.31	31	31	105	632,975	4,174,550

[a] Worst-case impact for applicable averaging time.
[b] Background represents the maximum value measured at Tracy or Stockton, 1995–2000 (except for SO_2, which was measured at Fresno).

AAQS = most stringent ambient air quality standard for the averaging period
m = meters
$\mu g/m^3$ = micrograms per cubic meter
CO = carbon monoxide
NO_2 = nitrogen dioxide
PM_{10} = particulate matter less than or equal to 10 microns in diameter
SO_2 = sulfur dioxide

Table 8.1-20
TPP Fumigation Impacts (1-hour)

Source	SCREEN3 Inversion 1-hr Result [µg/m3]/[g/s]	Emission Rate (g/s)	Maximum Impact (µg/m3)	Background (µg/m3)	Total	Lowest AAQS
Gas Turbine						
CO	0.5771	3.17	1.83	12,941	12,943	23,000
NO_2	2.671	2.54	1.47	224	225	470
SO_2	2.671	0.077	0.044	128	128	655
	2.671	0.077	0.044	128	128	1,300

Table 8.1-21
Commissioning Modeling Analysis Results

Pollutant	No. of Turbines[a]	Emission Rate per turb. (lb/hr)	Turbine Load	Modeling Results (µg/m3)	Back-ground (µg/m3)	Total Predicted Concen-tration (µg/m3)	AAQS (µg/m3)	Emission Rate Baasis
NO_2 1-hr	2	65	100%	81.38	224	305	470	2x uncontrolled rate
CO 1-hr	2	108	100%	135.2	12,941	13,076	23,000	2x uncontrolled rate
CO 8-hr	2	108	100%	72.52	9, 047	9,120	10,000	2x uncontrolled rate

[a] Emissions based on both turbines operating simultaneously.

Table 8.1-22
Modeled Stack Parameters for Cumulative Impact Analysis

Source ID	UTM Coordinates Easting (m)	UTM Coordinates Northing (m)	Base Elevation (m)	Stack Height (m)	Temperature (K)	Velocity (m/s)	Stack Diameter (m)
GWF_GT1	633083.8	4174618	54.00	30.48	727.59	36.27	5.182
GWF_GT2	633123.6	4174588	54.00	30.48	727.59	36.27	5.182
GT1	625968.8	4176031	118.87	64.00	358.71	16.809	5.791
GT2	626011.3	4176031	118.87	64.00	358.71	16.809	5.791
GT3	626095.8	4176031	118.87	64.00	358.71	16.809	5.791
GT4	626138.3	4176031	118.87	64.00	358.71	16.809	5.791

Table 8.1-23
Modeled Emission Rates for Cumulative Impact Analysis

Emission Rates Source ID	NO_x (lb/hr)	CO (lb/hr)	PM_{10} (lb/hr)	SO_2 (lb/hr)
GWF_GT1	17.51	8.18	9.59	0.51
GWF_GT2	17.51	8.18	9.59	0.51
GT1	14.00	26.70	10.8	1.68
GT2	14.00	26.70	10.8	1.68
GT3	14.00	26.70	10.8	1.68
GT4	14.00	26.70	10.8	1.68

Table 8.1-24
Cumulative Modeling Analysis Results

Pollutant	Averaging Period	Maximum Modeled Impact ($\mu g/m^3$)	Back-ground ($\mu g/m^3$)	Total Predicted Concen-tration ($\mu g/m^3$)	AAQS ($\mu g/m^3$)	UTM Coordinates East (m)	UTM Coordinates North (m)
							Cumulative Impacts
CO	1-hour	56.5	12,941	12,996	23,000	267600	3892300
	8-hour	24.1	9,047	9,071	10,000	267700	3892300
NO_2	1-hour	29.6	224	254	470	262000	3898000
	Annual	0.34	45	45	100	264000	3896000
PM_{10}	24-hour	3.76	150	154	50	267700	3892300
	Annual	0.25	36.4	37	30	267800	3892400
SO_2	1-hour	3.55	128	132	655	263000	3904000
	3-hour	1.84	--	1.8	1,300	264000	3895500
	24-hour	0.52	31	32	105	265000	3904000
	Annual	0.03	5.2	5.2	80	260000	3900000

Note: Cumulative modeling includes project turbines during normal operation only; emergency equipment not included.

Table 8.1-25
Rule 2201 Emission Offset Requirements for the TPP

Pollutant	Attainment Status	Rule 2201 Offset Threshold	Applicable Project Emissions
NO_x	A/NA[a]	10 ton/yr	153.5 ton/yr[c]
VOC	NA[b]	10 ton/yr	71.62 ton/yr[c]
PM_{10}	NA	80 lb/day	504.4 lb/day[d]
SO_2	A	150 lb/day	29.5 lb/day[d]
CO	A	550 lb/day	729.8 lb/day[d]

A = Attainment NA = Nonattainment

[a] The area attains both state and federal NO_2 AAQS, but NO_x emissions are considered a precursor to ozone. The area is classified nonattainment for both California and federal ozone AAQS.

[b] VOC emissions are considered a precursor to ozone, a nonattainment pollutant.

[c] Based on annual average emissions at 59 °F ambient and including emergency generator operations (annual testing hours).

[d] Based on worst-case daily emissions at 15 °F ambient and including emergency generator operations (one startup/shutdown per day).

Table 8.1-26
Comparison of TPP Offset Requirements under SJVUAPCD Rule 2201 and/or CEQA and Total ERCs Acquired or To Be Acquired by TPP

	NO_x	VOC	CO	PM_{10}	SO_2
TPP Project Emissions, ton/yr[a]	153.5	20.20	122.08	83.7	4.44
TPP ERCs at 1.2:1, ton/yr	19.1[b]	0	231.8	--	--
TPP ERCs at 1.5:1, ton/yr	164.4[b]	32.0	6.5	64.9	216.2
TPP SO2 ERCs at 2.5:1, ton/yr[c]	--	--	--	250[c]	--
Balance Required from SJVUAPCD Bank	18.0	0	0.7[d]	--	0

[a] See Appendix B for calculations
[b] Emission offset requirements reflect a 10 tpy reduction from stationary source potential to emit when determining offset requirements for new sources – see Rule 2201 Section 6.8.2.2. The 10 tpy reduction allowed for new sources is accounted for in the District Air Quality Attainment Plan Growth Allowance to ensure that overall levels of ozone precursors decline.
[c] Based on an SO2 for PM10 interpollutant offset ratio of 2.5 to 1.
[d] Small CO emission offsets shortfall in first quarter.

Table 8.1-27
Applicable Air Quality Permits or Approvals Required for the TPP

Agency	Permit Approval	Expected Filing Date
U.S. EPA Region IX	Prevention of Significant Deterioration	Not required
San Joaquin Valley Unified Air Pollution Control District	Determination of Compliance/Authority to Construct Permit Application	July 2001
	Acid Rain Permit Application	Within two years before startup (approximately August 2001)
	Title V Permit Application	Within one year after startup (approximately May 2002)

Table 8.1-28
TPP Summary of Compliance with Air Quality LORS

Authority	Administering Agency	Requirements	TPP Compliance	AFC Conformance Section
Federal CAAA of 1990; 40 CFR 50	U.S. EPA Region IX, CARB, SJVUAPCD	NAAQS	The TPP operations will not cause a violation of any national (or state) ambient air quality standard.	8.1.4.4
40 CFR 72, 73, 75	U.S. EPA Region IX	Acid rain requirements, SO_2 allowances.	The TPP will submit an acid rain permit application within two years before startup. CEM will be implemented.	8.1.5, 8.1.8
40 CFR 60, Subpart GG; SJVUAPCD Rule 4001	SJVUAPCD	NSPS; 0.010% by volume (100 ppmvd) for NO_x and 0.015% by volume (150 ppmvd) for SO_2.	The TPP emission rate for NO_x is 5 ppmvd at 15% O_2; the SO_2 emission rate is less than 1 ppmvd at 15% O_2. Both emission rates are well below the NSPS emission limit. Additionally, CEM plans will be developed and CEM will be performed.	8.1.3.1, 8.1.5, 8.1.8
40 CFR 70, SJVUAPCD Rule 2520	SJUVAPCD	Federally Mandated Operating Permit (Title V) for major sources	The TPP will be a major source as defined by SJUVAPCD rules 2201 and 2520. The Title V permit application will be submitted within 12 months of startup of the TPP.	8.1.1.5
California Administrative Code, Title 14, §15002(a)(3), CEQA Guideline	CEC	Power plant siting requirements.	This AFC satisfies the CEC requirements.	8.1

Table 8.1-28 (continued)
TPP Summary of Compliance with Air Quality LORS

Authority	Administering Agency	Requirements	TPP Compliance	AFC Conformance Section
Health and Safety Code § 44300	SJVUAPCD	Air Toxics "Hot Spots" emission inventory.	GWF will submit an Air Toxics "Hot Spots" information and assessment report.	8.1.1.7
Rule 2010	SJVUAPCD	ATC and PTO	The ATC and PTO application will be submitted in the third quarter of 2001.	8.1.1.8
Rule 2201	SJVUAPCD	New Source Review (NSR).	NSR requirements will be met by the TPP.	8.1.3, 8.1.4, and 8.1.5
Rule 4101	SJVUAPCD	Visibility; prohibits visible emissions as dark or darker than No. 1 on the Ringelmann chart	The TPP will ensure compliance with the rule by using natural gas and effective combustion practices. Excess visible emissions are not anticipated from properly operating natural-gas-fired combustion equipment.	8.1.3.1
Rule 4102	SJVUAPCD	Nuisance; prohibits discharge of emissions that cause injury, illness, detriment, nuisance, etc., to any considerable number of persons or to the public.	The TPP will ensure compliance with the rule by using natural gas for combustion and maintaining ammonia slip substantially below the odor threshold. The public health analysis (Section 8.6) also demonstrates that no significant adverse health impacts are expected.	8.1.3.1, 8.6

Table 8.1-28 (continued)
TPP Summary of Compliance with Air Quality LORS

Authority	Administering Agency	Requirements	TPP Compliance	AFC Conformance Section
Rule 4201	SJVUAPCD	Total suspended particulate emission limit of 0.1 gr/DSCF.	The maximum TPP emission rate for PM_{10} is 10 lb/hour (0.002 gr/DSCF), well below the TSP emission limit.	8.1.3.1
Rule 4703	SJVUAPCD	NO_x emission limit of 10.3 ppm at 15% O_2 and CO emission limit of 200 ppm at 15% O_2 for the gas turbine.	The TPP emission rate for NO_x is 5 ppmv at 15% O_2; the CO emission rate is 6.0 ppmvd. Both the NO_x and CO emission rates are well below the limits of the rule.	8.1.3.1
Rule 4801	SJVUAPCD	SO_2 emission limit of 0.2% by volume, dry (2,000 ppmvd).	The TPP emission rate for SO_2 is well below the rule 4801 emission limit.	8.1.3.1
Rule 8010	SJVUAPCD	Fugitive dust administrative requirements; reasonably available control measures (RACMs).	The TPP will use dust control measures (application of water) as necessary to achieve 50% control efficiency (minimum) according to Rule 8010 requirements.	8.1.3.5
Rule 8020	SJVUAPCD	Fugitive dust, construction; requires RACMs and prohibits opacity to exceed 40%.	The TPP will commit to implementing RACMs during construction and controlling opacity from construction to a level below 40% (for a period or periods aggregating to more than three minutes in any one hour) per Rule 8020 requirements.	8.1.3.5

Table 8.1-28 (continued)
TPP Summary of Compliance with Air Quality LORS

Authority	Administering Agency	Requirements	TPP Compliance	AFC Conformance Section

AFC	=	Application for Certification
ATC	=	Authority to Construct
CAAA	=	Clean Air Act Amendments
CARB	=	California Air Resources Board
CEM	=	continuous emissions monitoring
CEC	=	California Energy Commission
CEQA	=	California Environmental Quality Act
CFR	=	Code of Federal Regulations
CO	=	carbon monoxide
gr/DSCF	=	grains per cubic foot of gas at dry standard conditions
NAAQS	=	National Ambient Air Quality Standards
NO_x	=	nitrogen oxide
NSPS	=	New Source Performance Standards
NSR	=	New Source Review
O_2	=	oxygen
ppm	=	parts per million
ppmvd	=	parts per million by volume dry
PTO	=	Permit to Operate
RACM	=	reasonably available control measures
SJVUAPCD	=	San Joaquin Valley Unified Air Pollution Control District
SO_2	=	sulfur dioxide

FIGURES

Figure 8.1-1

Figure 8.1-2

Figure 8.1-3

Figure 8.1-4